

Helminth parasites of four species of strigiform birds from Central and Northeastern Argentina

Helmintos parásitos de cuatro especies de aves Strigiformes del Centro y Noreste de la Argentina

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ABSTRACT: The helminthofauna of eight specimens of four species of strigiform birds from Central and Northeastern Argentina was studied. From all the specimens studied, the 75 % were positive for helminths. Seven taxa, that were previously known, are briefly described, and seven new host-parasite associations are reported: the strigeid digeneans *Australapatemon magnacetabulum*, and *Strigea falconis brasiliensis*, and the acuariid nematode *Synhimantus* (*Synhimantus*) cf. *laticeps* (Acuariidae) associated with *Asio clamator*; the diplostomid digenea *Neodiplostomum travassosi* and the centrorynchid acanthocephalan *Centrorynchus* sp. parasitizing *Athene cunicularia*; the strigeid digenean *Strigea magniova* associated with *Tyto alba*; and the seuratiid nematode *Skrjabinura* sp. parasitizing *Megascops choliba*. The host-parasite relationships are discussed through the analysis of host-specificity, diet of birds and life cycle of helminths. The richness of helminth taxa of strigiforms studied was moderate (1-3 species by host) and the infection intensity very low (1-3). Five taxa, out of seven, are considered “bird generalist” and the remaining two, “raptor generalist”.

Keywords: Strigidae, Tytonidae, Digenea, Nematoda, Acanthocephala.

RESUMEN: Se estudió la fauna helmintológica de ocho ejemplares pertenecientes a cuatro especies de aves Strigiformes procedentes del Centro y Noreste de Argentina. El 75 % de los especímenes estudiados fue positivo para helmintos. Siete taxa, previamente conocidos, son brevemente descritos y siete nuevas asociaciones hospedador parásito son reportadas: los digeneos estrigeidos *Australapatemon magnacetabulum*, *Strigea falconis brasiliensis* y el nematode acuárido *Synhimantus* (*Synhimantus*) cf. *laticeps* asociados a *Asio clamator*; el digeneo diplostómido *Neodiplostomum travassosi* y el acantocéfalo centrorynquido *Centrorynchus* sp. parasitando a *Athene cunicularia*; el digeneo estrigeido *Strigea magniova* asociado a *Tyto alba* y el nematode seratido *Skrjabinura* sp. parasitando a *Megascops choliba*. Las relaciones hospedador-parásito son discutidas a través del análisis de la especificidad hospedatoria, la dieta de las aves y el ciclo de vida de los helmintos. La riqueza específica de los helmintos parásitos de los Strigiformes estudiados fue moderada (1-3 especies por hospedador) y la intensidad de infección fue muy baja (1-3). Cinco de los siete taxa de helmintos estudiados fue considerada “generalista en aves” y las dos taxa restantes, como “generalistas en rapaces”.

Palabras claves: Strigidae, Tytonidae, Digenea, Nematoda, Acanthocephala.

INTRODUCTION

Although 21 species of strigiform birds (20 Strigidae and 1 Tytonidae) inhabit Argentina, the information about their helminthofauna is scarce. At present, three species of nematodes were reported: *Synhimantus* (*Synhimantus*) *laticeps* (Rudolphi, 1819) Railliet, Henry et Sisoff, 1912 (Acuariidae) parasitizing the Barn Owl, *Tyto alba* (Scopoli, 1769), from Mar Chiquita, Buenos Aires Province (Etchegoin et al., 2000); *Hamatospiculum flagellispiculosum* Schuurmans Stekhoven, 1952 (Diplotriaeidae) in the Striped Owl,

Asio clamator (Vieillot, 1808) (cited as *Rhinoptynx clamator maculatus*), from Bella Vista, Tucumán Province, and *Thelazia longicaudata* Sandground 1933 (Thelaziidae) in the Rufous-legged Owl, *Strix rufipes rufipes* King 1827, from Santiago del Estero Province (Schuurmans Stekhoven, 1952).

The aim of this paper is to increase the knowledge of the diversity of helminth parasites from strigiform birds from Argentina.

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MATERIALS AND METHODS

Eight specimens of strigiform birds were examined for helminths, the Burrowing Owl, *Athene cunicularia* (Molina 1782) (n=1, Chivilcoy, 34°54'S; 60°01'W); *A. clamator* (n=1, San Clemente del Tuyú, 36°21'S; 56°43'W); *T. alba* (n=1, Chivilcoy, n=1, Saladillo, 35°38'S, 57°46'W) from Buenos Aires Province, and the Tropical Screech-Owl, *Megascops choliba* (Vieillot, 1817) (n=2) and *A. cunicularia* (n=2) from La Marcela farm (26°17'35"S; 59°08'38"W), Formosa Province. The birds were captured with authorization of Ministerio de Asuntos Agrarios of Buenos Aires Province and Ministerio de la Producción y Ambiente of Formosa Province. The specimens were dissected in the field, the viscera were preserved in 10% formalin, and transported to the laboratory for helminthological examination. The viscera were examined under stereoscopic microscopy, and the helminths were removed. The digeneans were stained with a 1:6 dilution in 96% ethanol of hydrochloric carmine, dehydrated and mounted in Canada balsam between cover glasses in order to facilitate handling and observation. The nematodes and acanthocephalans were stored in 70% ethanol, later the specimens were cleared in Amman's lactophenol or glycerin-alcohol solution and studied under light microscope (Langeron, 1942). Measurements are given in micrometres (µm) unless otherwise is stated, and the range followed by the mean in parentheses is included. The helminths were deposited in the Helminthological Collection of the Museo de La Plata (MLP), and the hosts in the Ornithological Collection of the MLP, La Plata (Argentina). The terms related to host-specificity were used according to Santoro et al. (2012): helminth species 'specialist' are those reported in a single host species; 'owl specialist' are those reported mainly, or only, in Strigiformes; 'birds of prey specialist', are the helminths species reported mainly, or only, in birds of prey (Accipitriformes and Falconiformes); "raptor generalist", those reported in both owls and birds of prey, and 'bird generalists', if it also occurred extensively in birds other than raptors.

This categorization was based on bibliographic data as well as in the samples collected in the present study.

RESULTS

From all the specimens studied, the 75 % (n=6) were positive to helminths. Seven helminth taxa (four digeneans, two nematodes and one acanthocephalan) were found (Table 1).

Trematoda

Family Strigeidae

Strigea falconis brasiliiana Szidat, 1929 (Fig. 1A).

Measurements (based on three specimens): Body distinctly bipartite, 2.147-2.456 (2.318 mm) in total length. Forebody 600-745 x 677-812 (696 x 754). Hindbody subcylindrical, without a true neck region or "Halstei", 1402-1750 x 411-580 (1622 x 504). Ratio of hindbody length to forebody length 1.9-2.9 (2.4). Oral sucker 76-117 x 145-181 (96 x 163), ventral sucker 208 x 237 and suckers width ratio 1.6. Pharynx 145 x 106. Proteolytic gland 179-193 x 193-222 (186 x 212). Testes in tandem, anterior testis 290-314 x 324-328 (302 x 326), posterior testis 266-338 x 242-348 (302 x 295). Preovarian region occupying 31-34 (33) % of hindbody. Ovary 98-193 x 112-155 (145 x 133). Vitellarium follicular in forebody, reaching up to pharyngeal region; in hindbody occupying its whole width in preovarian region and extending dorsally up to copulatory bursa. Vitelline reservoir intertesticular. Uterus with numerous eggs 102-119 x 57-69 (109-61). Copulatory bursa 150-208 x 256-391 (172 x 301), with muscular ring (*Ringnapf*) and genital cone.

Taxonomic Summary

Host: *Asio clamator*.

Site of infection: intestine.

Locality: San Clemente del Tuyú (36°21'S; 56°43'W), Buenos Aires Province, Argentina.

Distribution and hosts: *Strigea falconis brasiliiana* is considered a euryxenous species, because it has a broad spectrum of definitive hosts, including Accipitrid, Falconid, Larid, Ardeid, Cathartid, Phalacrocoracid,

Table 1. List of strigiform hosts including collection site, number of examined specimens and heminth taxa with prevalence (P%) and mean intensity (MI)

Hosts	Collection Site	Number of Specimens	Helminth Taxa	P%	MI
<i>Asio clamator</i>	Buenos Aires	1	<i>Strigea falconis brasiliiana</i> *	100	3
			<i>Synhimantus</i> (<i>Synhimantus</i>) cf. <i>laticeps</i> *	100	3
			<i>Australapatemon magnacetabulum</i> *	100	1
<i>Athene cunicularia</i>	Formosa	2	<i>Neodiplostomum travassosi</i> *	50	1
	Buenos Aires	1	<i>Centrorhynchus</i> sp. *	50	1
<i>Megascops choliba</i>	Formosa	2	-----	-----	-----
<i>Tyto alba</i>	Buenos Aires	2	<i>Skrjabinura</i> sp. *	50	1
			<i>Strigea magniova</i> *	100	1.5

* New host record.

and Rallid birds from Neotropical Region. In Brazil, was reported parasitizing the Roadside Hawk, *Rupornis magnirostris* (Gmelin, 1788); the White-tailed Hawk, *Geranoaetus albicaudatus* Vieillot, 1816; the Ornate Hawk-Eagle, *Spizaetus ornatus* (Daudin, 1800); the Southern Caracara, *Caracara plancus* (Miller, 1777); the Laughing Falcon, *Herpetotheres cachinnans* (Linnaeus, 1758); the Black Vulture, *Coragyps atratus* (Bechstein, 1793); the Rufescent Tiger-Heron, *Tigrisoma lineatum* (Boddaert, 1783); and *Sterna* sp. In Venezuela, was recovered from the Common Gallinule, *Gallinula galeata galeata* (Lichtenstein, 1818); in Cuba was found in the Red-tailed Hawk, *Buteo jamaicensis umbrinus* Bangs, 1901, and the Broad-winged, *Buteo platypterus cubanensis* Burns, 1911. In Argentina, was reported parasitizing the Yellow-headed Caracara, *Milvago chimachima* (Vieillot, 1816), *C. plancus*, *R. magnirostris*, and the Neotropic Cormorant, *Phalacrocorax brasilianus* (Gmelin, 1789) (Dubois, 1968; Dubois and Macko, 1972; Drago and Lunaschi, 2015; Fernandes et al., 2015).

This is the first report of *S. f. brasiliensis* in Strigiform birds and *A. clamator* represents a new host for this parasite species.

Remarks: The specimens obtained from *A. clamator* possess morphological characters similar to those described by Dubois (1968), except in the size of eggs (102-119 x 57-69 vs. 67-97 x 42-55). Also, are similar to specimens described by Lunaschi and Drago (2006), but differ by having larger body and eggs (2.147-2.456 mm vs. 1.305-1.392 mm; and 102-119 x 57-69 vs. 82-88 x 48-52, respectively).

***Strigea magniova* Dubois, 1988 (Fig. 1B).**

Measurements (based on three specimens): Body distinctly bipartite, 3.002-4.081 (3.441 mm) in total length. Forebody with a large aperture 0.774-1.257 x 1.000-1.171 (1.048 x 1.086). Hindbody subcylindrical 2.127-2.824 x 0.532-0.764 (2.393 x 0.632 mm) with neck region or "Halstei" of 1.141 mm in length, representing 40.4% of hindbody. Ratio of hindbody length to forebody length 1.9-2.9 (2.3). Oral sucker 130-193 x 193-198 (156 x 196), ventral sucker 193-290 x 188-266 (242 x 227) and suckers width ratio 0.9-1.4 (1.2). Pharynx 129-155 x 121-145 (142 x 133). Proteolytic gland 193-256 x 227-256 (225 x 242). Testes in tandem, anterior testis 503 x 484 and posterior testis 532 x 534. Ovary 217 x 232. Vitellarium follicular, densely distributed; in forebody extending from pharyngeal region up to intersegmental constriction; in hindbody occupying its whole width in preovarian region and extending dorsally up to copulatory bursa. Vitelline reservoir intertesticular. Uterus with numerous eggs 95-109 x 57-67 (105-61). Copulatory bursa 217-280 x 387-459 (249 x 423), with genital cone and muscular ring (*Ringnapf*).

Taxonomic Summary

Host: *Tyto alba*.

Site of infection: small intestine.

Locality: Chivilcoy (34°54'S; 60°02'W) and Saladillo (35°38'S; 57°46'W), Buenos Aires Province, Argentina.

Deposited material: MLP-He 7243 (one specimen).

Distribution and hosts: *Strigea magniova* was originally described parasitizing *R. magnirostris* from Paraguay. In Argentina, was reported parasitizing the same hosts from Formosa Province (Dubois, 1988; Lunaschi and Drago, 2006).

The finding of *S. magniova* in *T. alba* represents a new host record and extends the geographical distribution of this species to Buenos Aires Province (Argentina).

Remarks: The specimens obtained from in *T. alba* possess morphological and morphometric characters similar to those described parasitizing *R. magnirostris* by Dubois (1988) in Paraguay. Also, are similar to specimens described by Lunaschi and Drago (2006) except in the size of eggs (95-109 x 57-67 vs. 105-115 x 52-60).

***Australapatemon magnacetabulum* Dubois, 1988 (Fig. 1C).**

Measurements (based on one non-gravid specimen): Body distinctly bipartite, 1.721 mm in total length. Tegument smooth. Forebody calyciform, 754 x 503. Hindbody 1.3 times longer than forebody 967 x 445. Oral sucker terminal 105 x 131, ventral sucker in posterior middle of forebody 198 x 217, and suckers width ratio 1.66. Proteolytic gland at base of forebody 159 x 222. Prepharynx absent, pharynx well developed 93 x 71. Testes lobated, asymmetrical, in tandem, anterior testis 169 x 203, and posterior testis 169 x 261. Ovary cuneiform, 92 x 150. Vitellarium follicular, distributed in hindbody extending through ventrolateral surface to copulatory bursa. Vitelline reservoir intertesticular. Copulatory bursa large with terminal opening 275 x 319. Genital cone enclosing ejaculatory duct with internal rugae, 193 x 231. Excretory vesicle and pore, not observed.

Taxonomic Summary

Host: *Asio clamator*.

Site of infection: large intestine.

Locality: San Clemente del Tuyú (36°21'S; 56°43'W), Buenos Aires Province, Argentina.

Deposited material: MLP-He 7244 (one specimen).

Distribution and hosts: *Australapatemon magnacetabulum* [cited as *Apatemon (Australapatemon) magnacetabulum* Dubois, 1988] was described in Paraguay parasitizing the strigid *S. rufipes*, and the accipitrid *R. magnirostris* (Dubois, 1988). Their full life cycle was experimentally elucidated in Salta Province

(Argentina) including snails [*Biomphalaria tenagophila* (d'Orbigny, 1835)] naturally infected with sporocysts, metacercariae encysted in the parenchyma of the leeches, *Helobdella adiasola* Ringuelet, 1972, *Helobdella triserialis* (Blanchard 1849), *Haementeria eichhorniae* Ringuelet, 1978 and *Haementeria* sp., and adult specimens obtained from experimental hosts, the Domestic Red Junglefowl, *Gallus gallus* (Linnaeus, 1758) (Phasianidae), and the Mallard, *Anas platyrhynchos* Linnaeus, 1758 (Anatidae) (Davies and Ostrowski de Núñez, 2012).

The finding of *A. magnacetabulum* in *A. clamator* represents a new host record and extends the geographical distribution of this species to Buenos Aires Province (Argentina).

Remarks: The specimens obtained from in *A. clamator* possess morphological and morphometric characters similar to those described parasitizing *S. rufipes* and *R. magnirostris* by Dubois (1988) and those described from experimental hosts by Davies and Ostrowski de Núñez (2012).

Family Diplostomidae

Neodiplostomum travassosi Dubois, 1937 (Fig.1D).

Measurements (based on one specimen): Body distinctly bipartite, 1.571 mm. Forebody 1146 x 396, hindbody 425 x 387. Ratio of hindbody length to forebody length 0.37. Pseudosuckers absent. Oral sucker 69 x 71, ventral sucker 46.6 x 47.5, situated at 793 from anterior end, suckers width ratio 1.5. Holdfast organ 217 x 169, situated at 121 from ventral sucker. Pharynx 50 x 45, oesophagus 169, intestinal bifurcation at 294 from anterior end. Testes in tandem, anterior cuneiform testis, asymmetrical, 71 x 169, posterior testis symmetrical, 77 x 193. Vitellarium in fore and hindbody, beginning from midway between intestinal bifurcation and ventral sucker up to posterior end, pre-vitelline region in forebody 532. Eggs 98–100 x 59.5–62 (99 x 61).

Taxonomic Summary

Host: *Athene cunicularia*.

Site of infection: intestine.

Locality: La Marcela farm (26° 17' 35"S; 59° 08' 38"W), Formosa Province, Argentina.

Deposited material: MLP-He 7245 (one specimen).

Distribution and hosts: The adult specimens of *N. travassosi* parasitize a wide spectrum of phylogenetically unrelated birds: the Spectacled Owl, *Pulsatrix perspicillata* (Latham, 1790), the Crested Owl (Strigidae), *Lophotrix cristata* (Daudin, 1800) (Strigidae), *Strix* sp. (Strigidae), and the Red-billed Toucan, *Ramphastos tucanus* Linnaeus 1758 (Ramphastidae), from Brazil; *C. plancus* (Falconidae), the Savanna Hawk, *Buteogallus meridionalis* (Latham, 1790) (Accipitidae), and *P. brasiliensis*

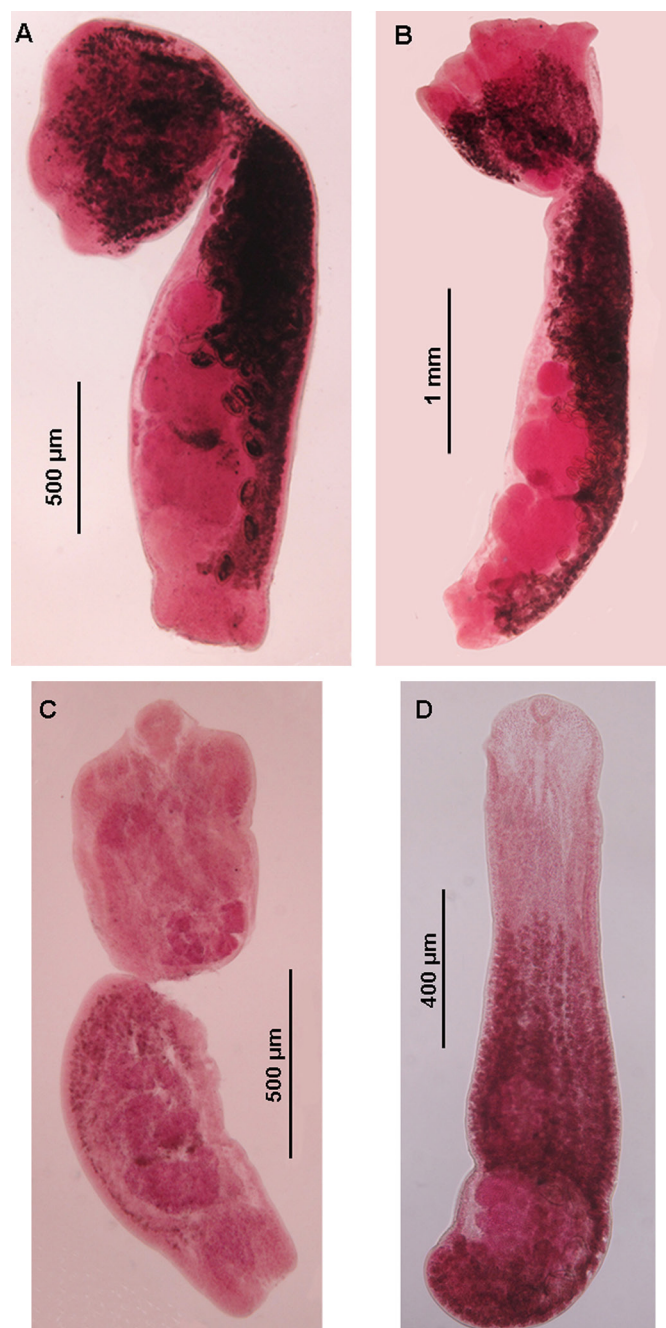


Figure 1. Trematoda of strigiform birds from Central and North-eastern Argentina. **A:** *Strigea falconis brasiliensis* from *Asio clamator*. **B:** *Strigea magniova* from *Tyto alba*. **C:** *Australapatemon magnacetabulum* from *Asio clamator*. **D:** *Neodiplostomum travassosi*

(Phalacrocoracidae) from Argentina (Dubois, 1970; Lunaschi and Drago, 2005; Drago et al., 2014).

The finding of *N. travassosi* in *A. cunicularia* represents a new host record.

Remarks: The specimens obtained from *A. cunicularia* possess morphological and morphometric characters similar to those described by Lunaschi and Drago (2005) and Drago et al. (2014) parasitizing other birds from Formosa Province (Argentina).

Nematoda

Family Acuaridae

Synhimantus (Synhimantus) cf. laticeps (Rudolphi,

1819) Railliet, Henry and Sisoff, 1912 (Figs. 2A, B). Measurements (based on three females): Cuticle with transverse striations. Length 10.1–12.4 (11.23) mm. Maximum width 0.51–0.59 (0.55) mm. Cordons recurrent, anastomosing on each lateral surface, 522–678 (626). Bucal capsule 256–454 (348) long. Nerve ring at 399 from anterior end. Excretory pore not observed. Deirids tricuspid, 15–19 (17) posterior to cordons, at 531–739 (636) from anterior end. Muscular oesophagus 169 in length. Vulva at 4–5.2 (4.6) mm from tip of tail. Larvated eggs 38–43 (39) long by 23–26 (24).

Taxonomic summary

Host: *Asio clamator*.

Site of infection: Proventriculus.

Locality: San Clemente del Tuyú (36° 21'S; 56° 43'W), Buenos Aires Province, Argentina.

Deposited material: MLP-He 7246 (three specimens).

Distribution and hosts: *Synhimantus* (S.) *laticeps* was cited in Accipitriformes, Falconiformes, Strigiformes, Ciconiiformes, Galliformes and Passeriformes birds from Europe, Asia, Australia and North and South America (Borgsteede *et al.*, 2003). Particularly, in Argentina, this acuariid was reported parasitizing *T. alba* from Mar Chiquita (Buenos Aires Province) (Etchegoin *et al.*, 2000).

This is the second report of *S. (S.) laticeps* in Argentina, and *A. clamator* represents a new host record.

Remarks: The specimens here studied are morphologically similar to those described by Cram (1927) and Etchegoin *et al.* (2000). The females obtained from *A. clamator* and the larvated eggs are larger than those described by Etchegoin *et al.* (2000) parasitizing *T. alba* (10.1–12.4 mm vs. 4.71–5 mm; 38–43 x 23–26 vs. 34.5–36 x 18–21), but these measurements are very close to those described by Cram (1927) in raptors from the Old World (11–21 mm; 38–42 x 25). Although no males were found, the presence of fertilized eggs in the uterus allows us to infer that *A. clamator* is a suitable host.

Family Seuratidae

***Skrjabinura* sp.** (Fig. 2C).

Measurements (based on one damaged female): Body spirally twisted 4 times, 50 mm long. Maximum width 2.7 mm. Oesophagus 938 long by 270 wide. Cephalic vesicle 580 long. Nerve ring and excretory pore situated at 358 and 822 from anterior end, respectively. Eggs embryonated, 116–145 long by 97–98 wide.

Taxonomic summary

Host: *Megascops choliba*.

Site of infection: intestine.

Locality: La Marcela farm (26° 17'35"S; 59° 06'38"W), Formosa Province (Argentina).

Deposited material: MLP-He 7247 (one specimen).

Distribution and hosts: In the Neotropical Region were reported *Skrjabinura vali* (Guerrero, 1971) Chabaud, 1978 parasitizing cuculiforms and passeriforms birds from Venezuela and Costa Rica; *Skrjabinura mesoamericana* Zhang and Brooks, 2005 in passeriforms and caprimulgiforms from Costa Rica; *Skrjabinura spiralis* Gnedina, 1933 parasitizing cuculiforms, piciforms, falconiforms and trogoniforms from Brazil, and *Skrjabinura* sp. in caprimulgiforms from Paraguay (Masi Pallarés and Benítez Usher, 1971; Vicente *et al.*, 1995, 1996; Magalhães Pinto *et al.*, 1996; Zhang and Brooks, 2005). Of these species, only *S. spiralis* was reported parasitizing strigid birds, such as the Eurasian Scops-Owl, *Otus scops* (Linnaeus, 1758) from Europe and the Northern Boobook, *Ninox japonica* (Temminck and Schlegel, 1845), from Taiwan (Schmidt and Kuntz, 1971; Santoro *et al.*, 2012).

The finding of *Skrjabinura* sp. in *M. choliba* represents a new host record and the first record of the genus in Argentina.

Remarks: Although no males were found, the particular morphology of body of female, spirally twisted, allow us to identify this specimen as member of the genus *Skrjabinura*. The presence of fertilized eggs in the uterus allows us to infer that *M. choliba* is a suitable host.

Acanthocephala

Family Centrorhynchidae

***Centrorhynchus* sp.** (Fig. 2D).

Measurements (based on one immature male): Body elongated, 1.914 mm in total length. Proboscis 440 long by 251 wide, divided into 2 portions by constriction at level of insertion of the proboscis receptacle; anterior portion of proboscis almost cylindrical, posterior portion conical. Proboscis armature with true, spiniform hooks, transitional hooks absent. Trunk cylindrical 1.628 mm long by 580 wide. Proboscis receptacle with double wall. Lemnisci digitiform, longer than proboscis receptacle, 716–793 long by 53–82 wide. Testes oval, contiguous, in tandem, in the third quarter of the body; anterior testis 159 long by 76 wide, posterior testis 135 long by 88 wide.

Taxonomic summary

Host: *Athene cunicularia*.

Site of infection: intestine.

Locality: La Marcela farm, (26° 17'35"S; 59° 08'38"W), Formosa Province, Argentina.

Deposited material: MLP-He 7248 (one specimen).

Distribution and hosts: In Argentina, a few reports of *Centrorhynchus* spp. are known, adults of *Centrorhynchus guira* Lunaschi and Drago, 2010 were cited parasitizing cuculid and threskiornithid birds, and of *Centrorhynchus tumidulus* (Rudolphi

1819) parasitizing didelphid marsupials (Boero and Boehringer, 1967; Lunaschi and Drago, 2010; Lunaschi *et al.*, 2015). Also, juveniles of *Centrorhynchus* sp. were cited parasitizing colubrids (Vizcaíno, 1993; Lamas and Lunaschi, 2009), and leptodactylids, hylids and bufonids (Duré *et al.*, 2004; González and Hamann, 2006; Hamann *et al.*, 2006a, 2006b, 2010, 2013). In Neotropical strigids, were reported *Centrorhynchus tumidulus* (Rudolphi, 1819) parasitizing *M. choliba* and *T. alba* from Brazil (Travassos, 1926), and *Centrorhynchus millerae* Smales 2013 in *M. choliba* from Paraguay (Smales, 2013).

The finding of *Centrorhynchus* sp. constitutes the first record of this genus parasitizing *A. cunicularia*.

Remarks: Although only one juvenile male were found, the presence of proboscis receptacle with double wall and the shape of proboscis, with the anterior portion almost cylindrical and a posterior portion conical, allow us to identify this specimen as member of the genus *Centrorhynchus*. The species identification is not possible, because males and females of *Centrorhynchus* may have different pattern of hooks, including species with transitional hooks only in females (Smales, 2013).

DISCUSSION

The helminth richness of the strigiforms studied was moderate (1-3 species by host) and the infection intensity very low (1-8). These results are consistent with others in the Palaearctic Region (Ferrer *et al.*, 2004; Sanmartín *et al.*, 2004; Santoro *et al.*, 2012). Raptors are located at the top of the food chain, and also, at the top of the indirect life cycles of many parasite species, whose presence in each host depends (among other factors) on the type and diversity of prey consumed by them (Sanmartín *et al.*, 2004). Raptors have similar ecological niches and food habits, but the helminthofauna of Strigiform birds is poor-species compared with other prey birds such as falconiforms and accipitriforms of the same region, being the helminth community of owls represented by a "subset" of that observed in other birds of prey (Sanmartín *et al.*, 2004; Santoro *et al.*, 2012). Usually, owls have a lower number of genera of helminths than diurnal raptors, and generally, lower prevalence among shared genera (Ferrer *et al.*, 2004). Several factors related with the hosts have been proposed as potential causes of these differences, such as host body size and trophic niche breadth, although the parasite specificity seems to be the more important factor to explain the greater diversity found in diurnal raptors (Ferrer *et al.*, 2004).

Asio clamator was the bird species with the great richness, with 3 helminth species: two strigeid digeneans (*A. magnacetabulum*, *S. f. brasiliensis*) and

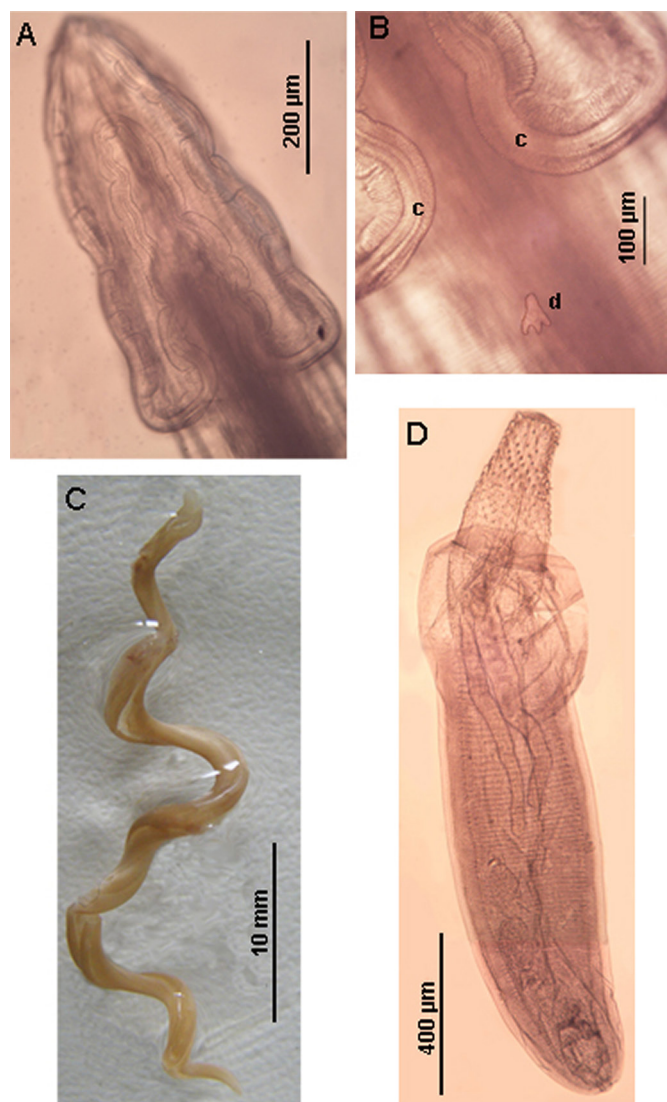


Figure 2. Nematoda and Acanthocephala of strigiform birds from Central and Northeastern Argentina. **A:** anterior end of *Synhimantus* (*Synhimantus*) cf. *laticeps* from *Asio clamator*. **B:** detail of deirid of *Synhimantus* (*Synhimantus*) cf. *laticeps*. **C:** *Skrjabinura* sp. from *Megascops choliba*. **D:** *Centrorhynchus* sp. from *Athene*

one acuariid nematode [*S. (S.) laticeps*]. The known life cycles of *Australapatemon* spp. involve leeches as second intermediate hosts, while species of *Strigea* use vertebrates (amphibians, snakes, birds or mammals) as intermediate hosts (Niewiadomska, 2002a). The known life cycles of *Synhimantus* spp. involve terrestrial isopods (Anderson, 2000). The presence of helminth species that uses vertebrates or invertebrates as intermediate hosts is related with the wide variety of prey consumed by these birds. The diet of *A. clamator* includes small mammals, birds, reptiles, and insects (Del Hoyo *et al.*, 1999). The finding of a single immature specimen of *A. magnacetabulum* would indicate that this is an accidental infection, and was probably acquired by ingestion of leeches.

Athene cunicularia harboured two taxa: one diplostomid digenean, *N. travassosi* and one acanthocephalan, *Centrorhynchus* sp. The first of

these species uses amphibians, reptilians or mammals as second intermediate host (Niewiadomska, 2002b), and the later, mainly uses terrestrial isopods as first intermediate host while amphibians, and reptiles play a main role as paratenic hosts (Amato *et al.*, 2003). The diet of *A. cunicularia* includes small vertebrates (amphibians, reptiles, birds, and mammals, mainly rodents) and arthropods (insects and arachnids) (De Tommaso *et al.*, 2009). The presence of a single, and immature specimen of *Centrorhynchus* sp. would indicate the occasional ingestion of isopods.

Tyto alba was only parasitized by the strigeid digenean *S. magniova*. Life cycle of this strigeid species is unknown, although vertebrates are intermediate hosts in the life cycle of different species of the genus *Strigea*. The diet of *T. alba* includes mammals, birds, reptiles, amphibians, and insects, being rodents, marsupials, and bats the most abundant preys (Belloq, 2000). The low intensity of *S. magniova* (3) can be associated with the preferred preys of the host, rodents, since a few mammals have been reported as intermediate hosts of species of *Strigea* (Dubois, 1968).

Megascops choliba harboured also, only one species, the seuratid nematode, *Skrjabinura* sp. The life cycle of this genus is unknown, but among the few seuratids in which the cycle is known, insects are intermediate hosts. The diet of this bird species is mainly insectivorous, feeding on Orthoptera, Mantodea, Blattodea, Heteroptera, Coleoptera, and Lepidoptera, and to a lesser extent on mammals, and birds (Bó *et al.*, 2007; Delgado Vélez, 2007). So, the potential intermediate host of the species of *Skrjabinura* could be found among these orders of insects.

Strigea falconis brasiliensis is considered a “bird generalist” as it parasitized a broad spectrum of hosts, including Larid, Ardeid, Cathartid, Accipitrid, Falconid, Phalacrocoracid, and Rallid birds (Lunaschi and Drago, 2013). Also, *Neodiplostomum travassosi* was a “bird generalist” considering parasitized four species of strigids, *P. perspicillata*, *L. cristata*, *Strix* sp. and *A. cunicularia* (present study) as well as a wide spectrum of birds, including species of Ramphastidae, Phalacrocoracidae, Falconidae, and Accipitridae (Dubois, 1970; Drago *et al.*, 2014). *Synhimantus (Synhimantus) laticeps* was reported parasitizing Strigiformes, Accipitriformes, Falconiformes, Ciconiiformes, Galliformes and Passeriformes (Borgsteede *et al.*, 2003), so is considered “bird generalist”. Species of *Skrjabinura* parasitize a wide spectrum of birds, such is the case of *Skrjabinura spiralis* reported in five different orders, including Strigiformes and is considered as “bird generalist” by Santoro *et al.* (2012). Probably *Skrjabinura* sp. found

parasitizing *M. choliba* (present study), is a “bird generalist”. Species of *Centrorhynchus* parasitized a broad spectrum of phylogenetically unrelated birds (Lunaschi and Drago, 2010), then *Centrorhynchus* sp. from *A. cunicularia* is probably a “bird generalist”. *Australapatemon magnacetabulum*, up to now, was reported in two strigid birds, *S. rufipes* and *A. clamator* (present study), and one accipitrid bird, *R. magnirostris* (Dubois, 1988), then can be considered as a “raptor generalist”. *Strigea magniova* was reported in one accipitrid bird, *R. magnirostris* (Lunaschi and Drago, 2006) and one strigid bird, *T. alba* (present study), so can also be considered a “raptor generalist”.

Considering the host-specificity, the majority of helminths (five species) found in this study are “bird generalist”, and the other two, are “raptor generalist”. Usually, the parasite community of owls are dominated by species considered “bird generalist” or “raptor generalist”, followed by species considered “birds of prey specialist” or “owl specialist”, and few, or no “specialist” species (Santoro *et al.*, 2012).

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